THE VARIATION OF GLACIERS. VIII.[1]

THE following is a summary of the Sixth Annual Report of the International Committee on Glaciers:[2]

REPORT OF GLACIERS FOR 1901.

Swiss Alps.—Of the ninety-four glaciers which have been observed by the Swiss Foresters all, with one exception, are retreating. We have no reason to think that the other sixty-eight known glaciers which have not been specially observed are doing differently. The only glacier advancing in 1901 was the Boveyre, in the Valais. Its advance, which has amounted to one hundred and eight meters in ten years, is the result of a large avalanche which fell upon the glacier and so increased its thickness as to permit a considerable increase in length before the ice melted. A few glaciers show a hesitancy in their retreat, but this does not alter the statement that the Swiss glaciers are receding.[3]

Eastern Alps.—The greater number of the fifty-five glaciers observed are retreating. A small number, however, are advancing. The most remarkable of all these is the Vernagt glacier, in the Oetzthal, which has continued its remarkable advance and has gained fifty meters since 1900. Its velocity has increased at the same time from 210 to 250 meters a year. No glacier of the Alps within the last fifty years has shown so remarkable a growth.

The independence of neighboring glaciers with regard to their advance or retreat is sometimes characteristic even of different parts of the same glacier. For instance: Presena glacier, in the Adamello group, has three tongues; in 1901 the central was sensibly longer than in 1895; the other two, on the contrary,

[1] The earlier reports appeared in the JOUR. GEOL., Vol. III, pp. 278–88; Vol. V, pp. 378–83; Vol. VI, pp. 473–6; Vol. VII, pp. 217–25; Vol. VIII, pp. 154–9; Vol. IX, pp. 250–54; Vol. X, pp. 313–17.

[2] *Archives des sciences phys. et nat.*, Geneva, Vol. XII (1902), pp. 282–302.

[3] Report of Professor Forel and M. Muret.

were much shorter. The Gaisbergferner in the Oetzthal also exhibits certain peculiarities; the right half was advancing up to 1895, but has since then retreated; whereas the left half was retreating from 1894 until two years ago (with the exception of one year, 1898–99), and is now advancing.[1]

Italian Alps.—All the glaciers observed in the Italian Alps are retreating. On the south side of Monte Rosa a few small glaciers have disappeared altogether. A historical study of the two following glaciers show these variations:

Macugnaga glacier: Advance, 1780; retreat, ?; great advance, 1820; retreat, 1820–45; advance, 1845–60; retreat, 1860–81; advance, 1881–93; retreat, 1893—.

Lys glacier: Advance, end of seventeenth century; retreat, ?; advance, 1820; retreat, 1820–52; advance, 1852–59; retreat, 1859–84; advance, 1884–89; retreat, 1889—.[2]

French Alps.—The only observations made of the French glaciers are in the groups of the Pelvoux and of the Chambeyron, in Dauphiné, where all the glaciers observed are in retreat. The glacier Blanc, which has lately been advancing, has joined the general retreat. The Marinet glaciers, the most southerly in the French Alps, are decreasing very remarkably. In general the glaciers of Dauphiné are retreating strongly, with the probability that before long some of them will entirely disappear.[3]

Scandinavian Alps.—One glacier in the mountains north of Kvikkjökle, in Lapland, retreated ten meters from 1900 to 1901. This may be due to the extraordinary heat of last summer, when the maximum temperature of Kvikkjökle was above 60° F. The Suotes glacier, on the other hand, has advanced fifteen to twenty meters since 1896.[4]

Caucasus.—All the glaciers which have been visited are retreating, with the exception of the Devdorak, which is advan-

[1] Report of Professor Richter. These peculiarities are undoubtedly the result of the different parts of these glaciers being fed from different reservoirs.

An excellent historical study of the literature of moraines has been made by DR. AUGUST BÖHM, with references to the original sources of information. *Abhand. d. K. K. Geograph. Gesells. in Wien*, 1901, Vol. III, No. 4.

[2] Report of Professor Porro. [3] Report of M. Kilian. [4] Report of M. Svenonius.

cing. Stations have been fixed for the future study of a number of glaciers, and many new glaciers not heretofore known have been discovered.

Nova Zembla.—Colonel Wilkizky has discovered a number of large glaciers on the eastern side of the northern island, which reach the sea and form icebergs.

REPORT ON THE GLACIERS OF THE UNITED STATES FOR 1902.[1]

The ice shaken from Muir glacier by the earthquake in September, 1899, still prevents steamers from approaching the glacier. Last summer one of the steamers succeeded in going to within four miles of the glacier, and the captain reports that a new face can now be seen over the floating ice. From his descriptions and the sketch he made it appears that the new face is about a mile and a half back of its former position; and the nunatak bounding Morse glacier on the north is now washed by the inlet (*Davidson*). It is probable also that Dirt glacier has been separated from Muir.

Explorations in the Copper river basin lead to the conclusion that the maximum glaciation of this region was far more extensive than has hitherto been recognized. It seems that the Wrangell and the Alaskan mountains were the centers of a great ice-sheet which flowed southward well up into the Chugach mountains; and that the latter range also supported a continuous sheet of ice on the southern flanks[2] (*Schrader* and *Spencer*).

According to Indian tradition, Miles and Childs glaciers, which lie on opposite sides of the Copper river, were formerly united, and the river flowed under them. Between 1894 and 1898 the southern side of Miles glacier retreated five or six miles, and the Childs glacier five or six hundred yards. Between 1894 and 1902 Valdez glacier and Shoup glacier, near by, retreated about a mile; the latter was at the water's edge in 1884[3] (*Abercrombie*).

[1] A synopsis of this report will appear in the Eighth Annual Report of the International Committee. The report on the glaciers of the United States for 1900 was given in this JOURNAL, Vol. X, pp. 316, 317.

[2] "The Copper River District, Alaska," *Twenty-second Ann. Rept. U. S. Geol. Surv.* A map accompanies the report and shows the location of many large glaciers, but no information is given regarding their present variations.

[3] The Copper River Exploring Expedition, 1899.

There are no reports of the glaciers of Mount Hood and Mount Adams, but there was a greater snow-fall on Adams in 1902 than in 1901; and even in 1901 the snow lasted very late, being still in the timber in the middle of August (*Rusk*).

A dozen small glaciers about the heads of Kern and King rivers in the Sierra Nevada mountains of California have receded slightly in the last few years (*Muir*). The snow-fall in these mountains has been below the average for some years (*Le Conte*).

In the Rocky mountains of Colorado also the snow-fall for the past three years has been deficient and the summer melting excessive. As a consequence Arapahoe glacier is rapidly retreating, as shown by masses of débris-covered ice in advance of, and disconnected from, the glacier. Also a recently deposited moraine which stands about forty feet above the present level of the ice is so extremely fresh that the fine gravel and mud have been scarcely affected by the rain. Professor Fenneman thinks the ice was level with it within a year, which indicates a melting down of forty feet in that time. Photographs taken in former years show this moraine standing above the ice; so that, if the conclusion drawn above is correct, the Arapahoe glacier has experienced unusually violent fluctuations within the past few years. This small glacier, with an area of about a quarter square mile only, apparently exhibits the phenomena of the blue bands and stratification extremely well[1] (*Fenneman*).

A number of glaciers in northern Montana have been visited and mapped during the past summer. They are the remnants of much larger glaciers; only one or two have areas approaching three square miles. They appear in general to occupy shelves on the mountain sides and are broader than they are long. So far as could be observed, their moraines show that they are shrinking (*F. E. Matthes, by permission of the director of the U. S. Geological Survey*).

HARRY FIELDING REID.

GEOLOGICAL LABORATORY,
JOHNS HOPKINS UNIVERSITY,
April 8, 1903.

[1] "The Arapahoe Glacier in 1902," this JOURNAL, Vol. X (1902), pp. 839–51.